

The Lunar Atmosphere and Dust Environment Explorer (LADEE) Mission

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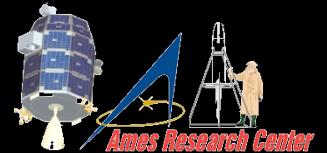
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⁶MIT Lincoln Labs, Lexington MA 02421



Mission Overview

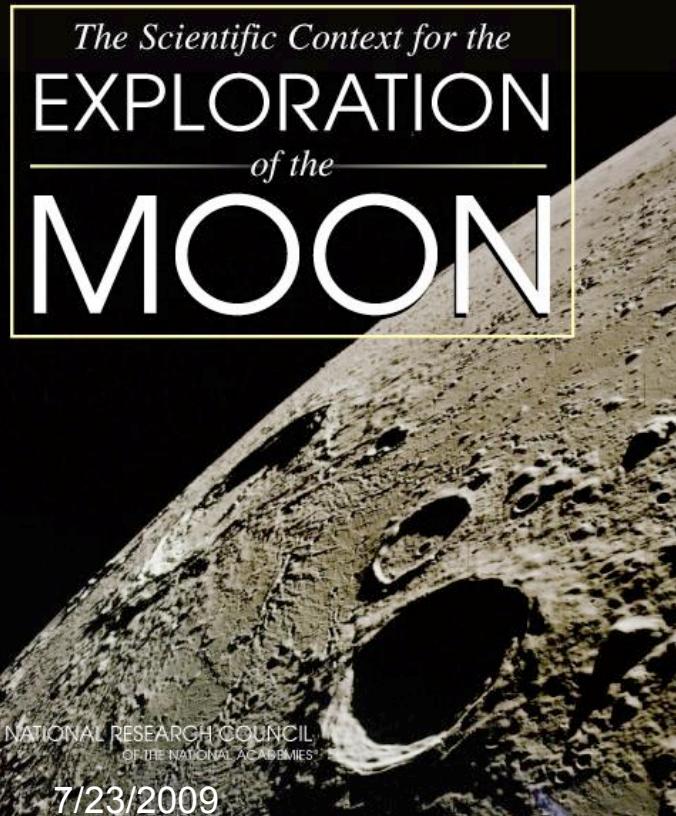
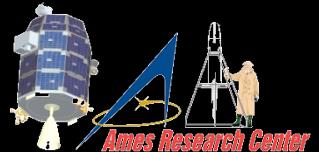


LADEE Mission Goals:

- Characterize the lunar atmosphere, including dust
- Test laser communication capabilities
- Demonstrate a low-cost lunar mission:
 - Simple multi-mission modular bus design
 - Low-cost launch vehicle



Motivation & Context



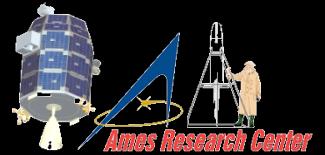
The top eleven science goals identified in the National Research Council (NRC) report, “Scientific Context for the Exploration of the Moon” (SCEM) include:

- a. Determine the global density, composition, and time variability of the fragile lunar atmosphere before it is perturbed by further human activity
- b. Determine the size, charge, and spatial distribution of electrostatically transported dust grains and assess their likely effects on lunar exploration and lunar-based astronomy.

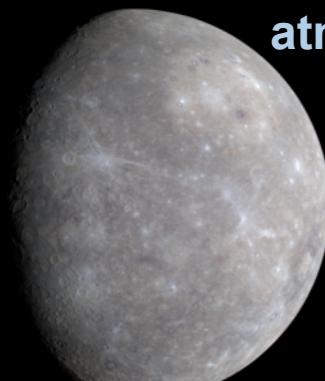
Similar objectives outlined in the 2003 NRC Decadal Survey: “New Frontiers in the Solar System: An Integrated Exploration Strategy”
Objective Sci-A-9 in the current LEAG Roadmap



Exospheres and Dust



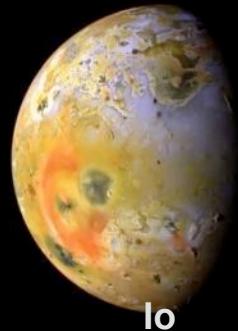
Surface Boundary Exospheres (SBEs)
may be the most common type of
atmosphere in the solar system...



Mercury



Moon



Io



Europa &
other Icy
satellites



Large
Asteroids
& KBOs



Evidence of dust motion on
Eros and the Moon....

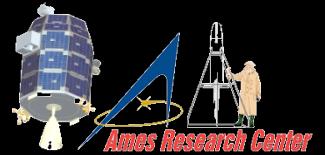


Eros

Surveyor 7: 1968-023T06:21:37



Mercury



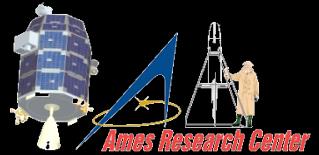
Mercury

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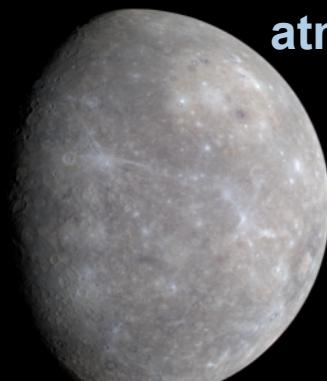
- Ca, Mg observed in addition to He, Na, K
- Possible water group ions – polar volatiles?
- Dependencies on magnetospheric configuration and solar conditions



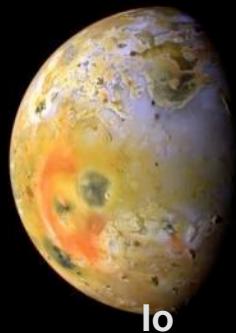
Exospheres and Dust



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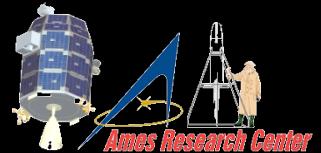


Eros

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The Moon



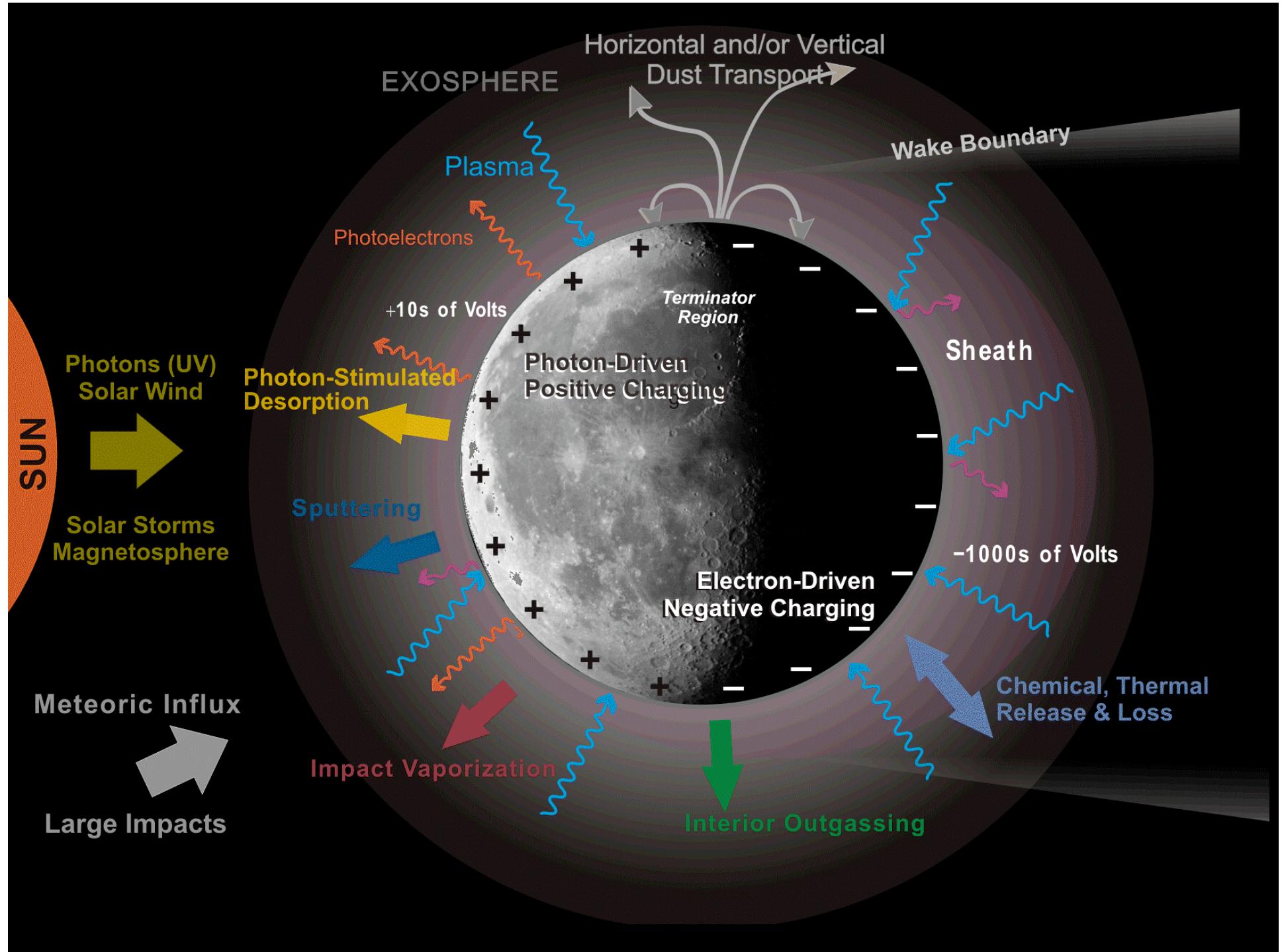
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Moon

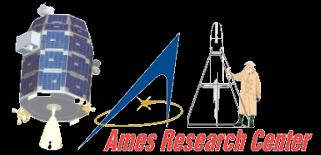
***The Moon is an ideal
“natural laboratory” to
study SBE and dust
processes and
dynamics***

- We have lunar samples, remote sensing data
 - Constrain surface boundary conditions
- Nearby
 - Inexpensive and easy to get to
- Wide range well characterized environmental conditions
 - Enables test of competing mechanisms
- Important to do now while in a pristine state

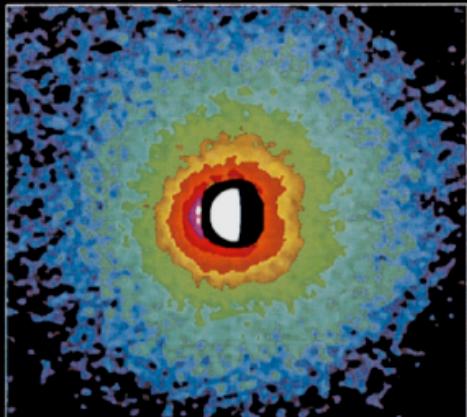




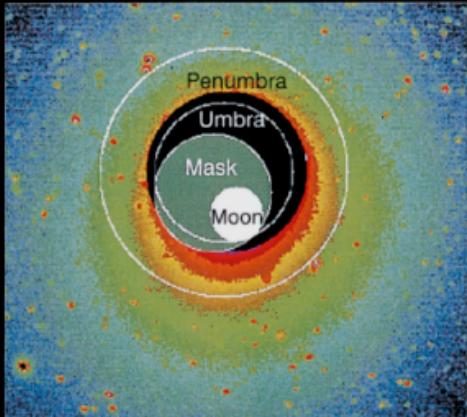
Lunar Exosphere



30 September 1991



29 November 1993



Na Emissions in Rayleighs



Mendillo et al 1997

5 10 20 41 84 169 342 692 1400

(ESCAPE ORBIT)

Cold-trapping in polar regions

Formation of lunar volatiles

Vondrak & Crider, 2003

Stern, 1999; Smyth &
Marconi 1995

Particle dynamics,
sources, sinks

(ESCAPE ORBIT)

PHOTOIONIZATION

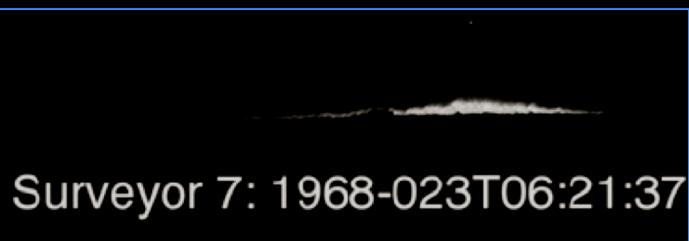
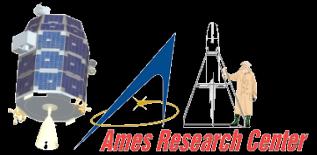
$h\nu$

e^-

A^+



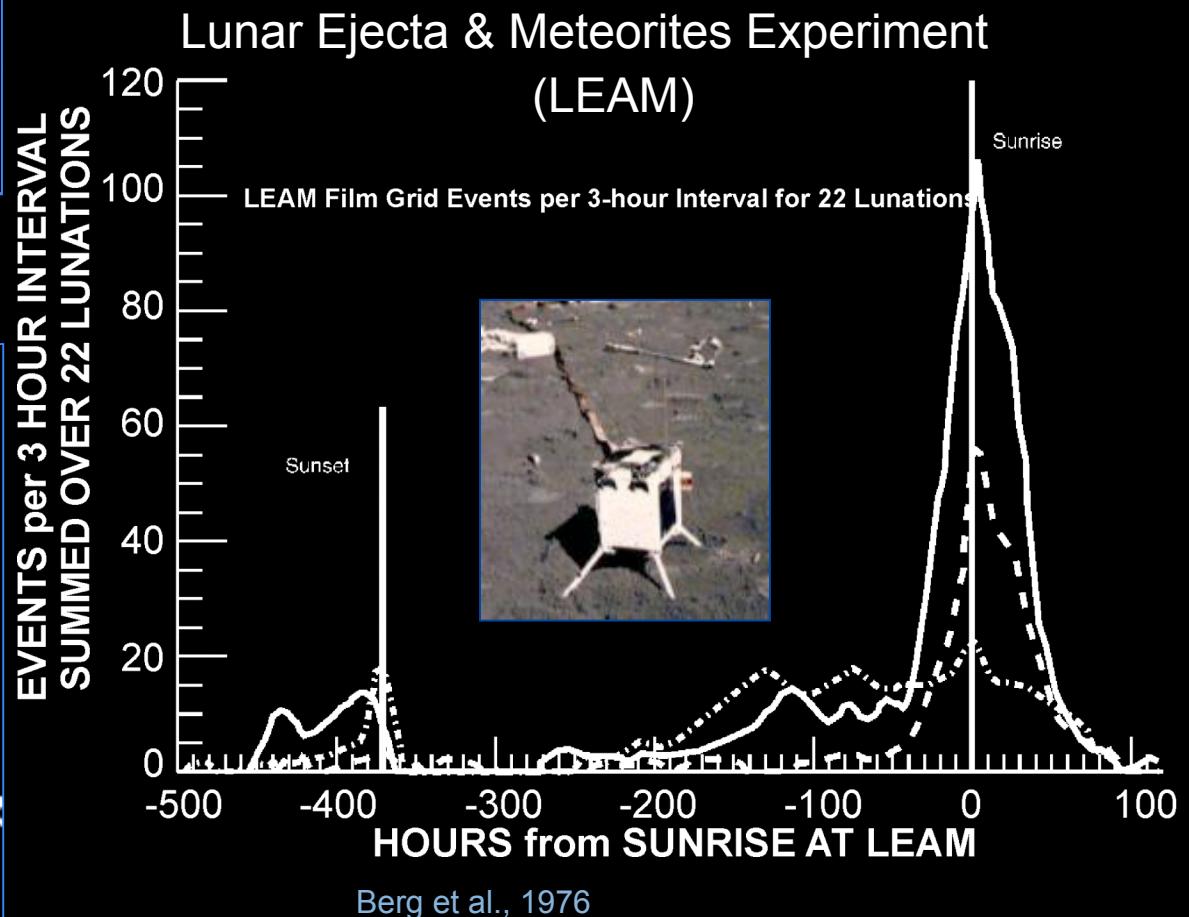
Lunar Dust Activity



Criswell, 1973;
Rennilson and Criswell, 1974

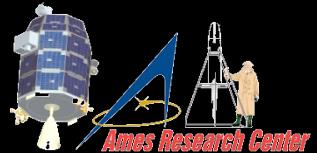


Apollo Astronaut sketch (G. Cernan)





LADEE – Instrument Payload



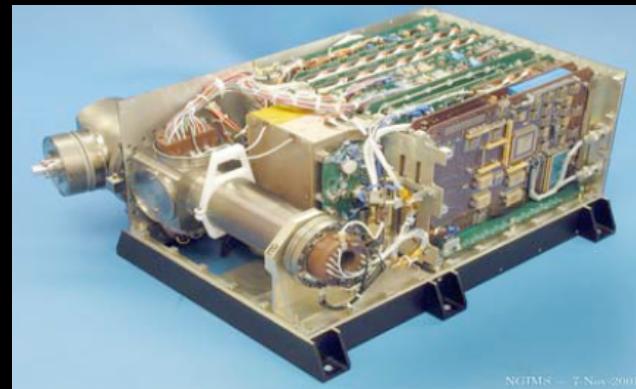
Neutral Mass Spectrometer (NMS)

MSL/SAM Heritage

SMD - directed instrument

In situ
measurement of
exospheric
species

P. Mahaffy
NASA GSFC



150 Dalton range/unit mass resolution

UV Spectrometer (UVS)

LCROSS heritage

SMD - directed instrument



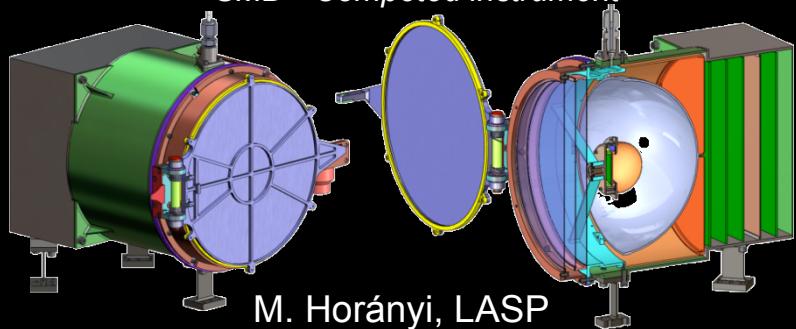
Dust and exosphere
measurements

A. Colaprete
NASA ARC

Lunar Dust EXperiment (LDEX)

HEOS 2, Galileo, Ulysses and Cassini Heritage

SMD - Competed instrument



M. Horányi, LASP

7/23/2009

NSLI 2009

Lunar Laser Com Demo (LLCD)

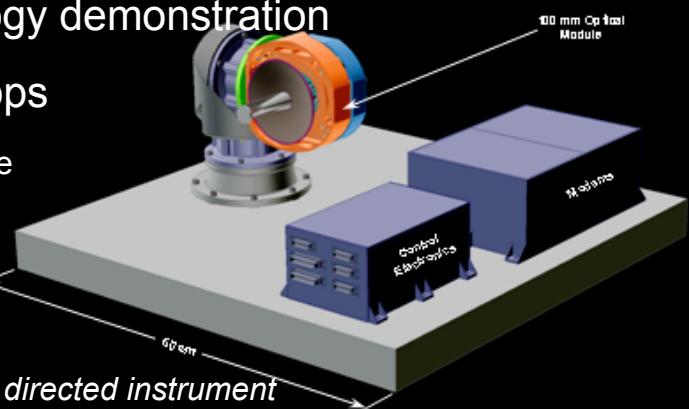
Technology demonstration

50-650 Mbps

High Data Rate
Optical Comm

D. Boroson
MIT-LL

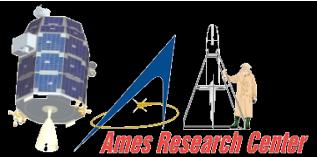
SOMD - directed instrument



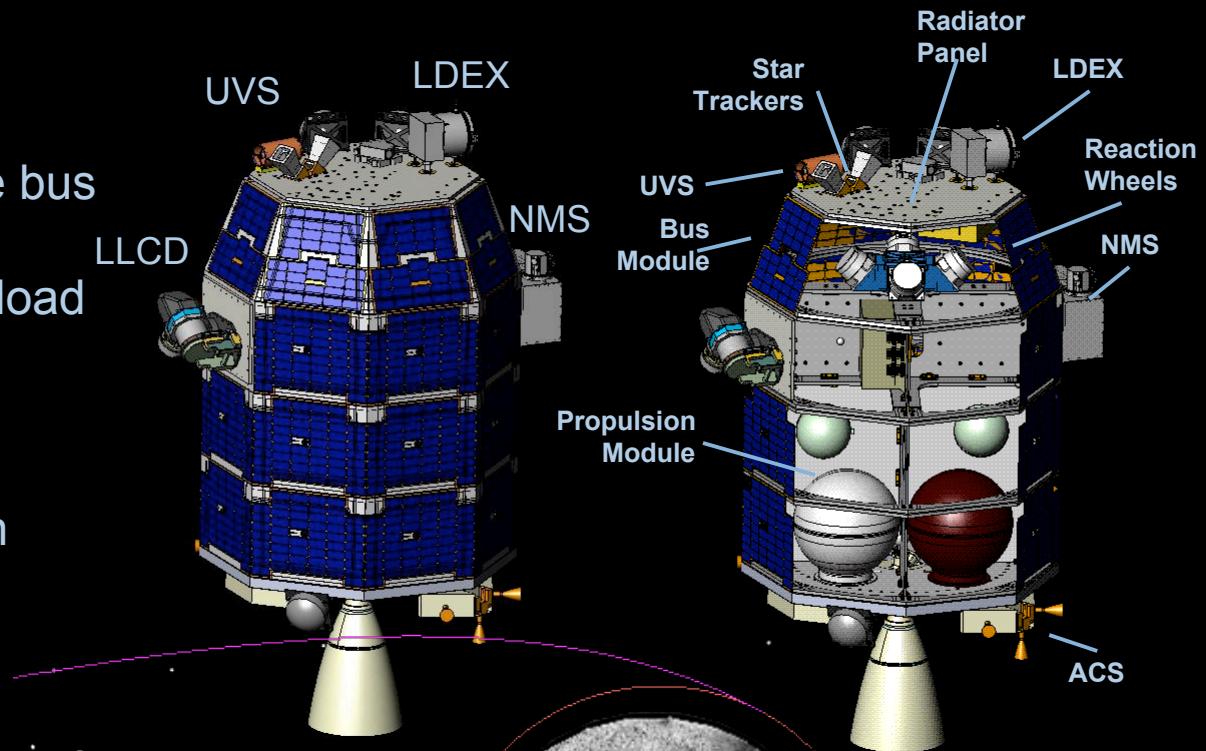
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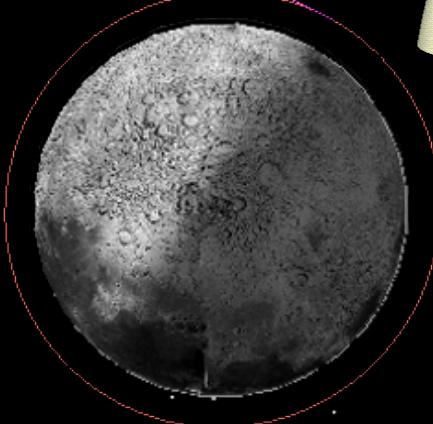
LADEE Mission



- Modular, composite bus design
- 53 kg payload
- 3-axis stabilized
- Bi-prop propulsion



- Direct transfer w/phasing orbits
- 30d Laser comm ops @ 250 km
- Elliptical low altitude equatorial orbit (25 x 75 km)
- 100 day science ops



- Minotaur IV+ low-cost LV
- Launch from Wallops, 2011-2012

LADEE's Role in Lunar Science

